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Carnegie Mellon University
Software Engineering Institute

Quarterly Update

January–March 1993

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Carnegie Mellon University

Software Engineering Institute

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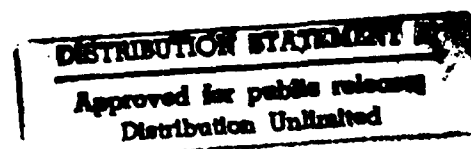
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Summary of Accomplishments: 1Q93

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This section provides a summary of accomplishments from January — March 1993

Software Project Measurement Project members completed the document entitled "Measurement Definitions for Department of Defense Software Programs: Recommendations for an Initial Core Set."

This quarter, **Software Process Definition Project** members completed the transition of the Software Technology for Adaptable, Reliable Systems Program and SEI Process Asset Library to ASSET, an electronic software engineering asset repository.

Capability Maturity Model Project members completed **Version 1.1** of the **CMM**.

The first edition of the **RMA handbook** was completed and will be published by Kluwer Academic Publishers in the summer of 1993.

The paper entitled "Multimedia Computing: Applications, Designs, and Human Factors" will appear in *User Interface Software.*

This quarter, **Organization Capability Development** staff conducted the "Managing Technological Change" course for executives for Army Materiel Command and the Air Force Materiel Command.

The **technical report** entitled *Academic Legitimacy of the Software Engineering Discipline* was published this quarter.

Academic Education Project members conducted faculty development workshops in conjunction with the 24th ACM Special Interest Group on Computer Science Education Technical Symposium on Computer Science Education.

Software Construction with Ada was released as a new **Academic Series** course.

The **curriculum module** *Specification and Verification of Concurrent Software* was released this quarter.

The next two **Visitor's Days** are scheduled for 27 May and 18 November 1993.

The SEI will host the annual **Software Engineering Symposium** on 23-28 August 1993.

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Software Process

The Software Process Program focuses on improving the process of software development. Projects within the program are assessing the actual practice of software engineering in the defense community, training organizations to gain management control over their software development processes, supporting the use of quantitative methods and measures as a basis for process improvement, and developing improved methods for software process management.

The objective of the Software Process Measurement Project is to promote and improve the use of measurement in managing, acquiring, and supporting software systems. The project is formulating reliable measures of the software development process and products to guide and evaluate development. To expedite Department of Defense (DoD) and industry transition, the project is actively working with professionals from industry, government, and academia in encouraging organizations to use quantitative methods to improve their software processes.

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Software Process Measurement

This quarter, project members prepared task plans and held a task plan review with the project team for the proposed software cost estimation improvement initiative.

Strategic and technical industry partnering meetings were held with Hewlett Packard (HP) and IBM Facilities Steering Committee.

In support of the measurement effort at Standard Systems Center (SSC), Gunter Air Force Base (AFB), project members held peer reviews of three technical reports: *Establishing a Software Measurement Process, Measurement and the Implementation of Process Improvement Recommendations,* and *Measuring the Benefits of Software Process Improvement.*

Also during this quarter, three site visits were conducted in support of measurement work at the Army Materiel Command (AMC), Fort Sill site in Lawton, Oklahoma.

This quarter, four site visits were conducted in support of the Naval Air Warfare Center (NAWC) technical objectives and plans (TO&P) effort. Project members participated in a NAWC Program Management Review, held by the pilot project. A presentation of the measurement program and results from the data analysis were well received.

Through the project's support, NAWC was recognized as the Naval Air Systems Command (NAVAIR) Metrics Center of Excellence. A progress report summarizing the accomplishments for 1992 was also completed and sent to the sponsor.

The project's resident affiliate from Siemens completed several case study site visits. The interviews and site visits were completed for the initial ten sites in Germany and the U.S. An overview of the case study sites was generated that summarized the characteristics of each organization. A project review was held in January, when it was decided that the joint project between the SEI and Siemens could provide initial methods for a more broad SEI validation study. A white paper was generated to identify a basic set of organization performance measures.

In response to a request from the Advanced Research Projects Agency (ARPA), the project leader prepared a white paper entitled "Software Measurement: Embedding Quantitative Principles into Software Engineering." The project leader provided a walkthrough of the paper and provided a presentation on the current and future activities of the measurement project to Dr. Ed Thompson and Dr. Jack Kramer of ARPA, and to the Joint Advisory Committee.

Project members hosted a meeting with the Measurement Steering Committee to discuss the status of current activities, future directions, and new initiatives.

Members of the measurement project held technical discussions with personnel from Defense Information Systems Agency/Center for Information Management to discuss SEI support for their pilot projects on using the SEI measurement definition checklists.

Project members completed the report entitled "Measurement Definitions for DoD Software Programs: Recommendations for an Initial Core Set," which will be published in the 1993 SEI Technical Review.

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Software Process Definition

The objectives of the Software Process Definition Project (SPD) are to establish the use of defined processes for the management and development of software as standard software engineering practice and to advance the capabilities required to define and automate the software process within an organization. A "defined process" means that a process is documented, supported by training, and practiced, and that the practice, training, and documentation are equivalent. SPD project members are exploring process definition methods and techniques through collaboration with several SEI sponsors including: Air Force SSC;

Gunter AFB; AMC at Picatinny Arsenal, Redstone Arsenal, Ft. Monmouth; and Air Force Materiel Command (AFMC). The project is also exploring advanced applications of process definition technology through the ARPA Software Technology for Adaptable, Reliable Systems (STARS) Program.

During this quarter, project members met with the SSC command section to discuss a special report on process improvement lessons learned. Project members also met with the Software Engineering Process Group (SEPG) at SSC to review the results of recent SEPG process development work, and to plan future activities.

Project members completed a detailed analysis and review of a configuration management process, Configuration Management Operating Procedure, at Picatinny Arsenal. The analysis used the process framework that is based on the capability maturity model (CMM) process framework as a baseline for comparison. This framework contains process criteria for the CMM key practice areas.

Project members continue to provide support to the ARPA/STARS demonstration projects and Process Technology Transition Affiliates (PTTA). Project members also continue to provide limited technical support for the ARPA STARS/SEI Process Asset Library, which is a joint effort between an SEI resident affiliate from GTE, STARS prime contractors, and the SEI.

This quarter, project members completed the transition of the STARS/SEI Process Asset Library to ASSET, an electronic software engineering asset repository. Project members are supporting the development of a prescriptive process model for the STARS/IBM demonstration project. Project members also met with representatives of the STARS demonstration project support teams and PTTAs to establish joint activities, including the transition and application of various SPD products to STARS demonstration projects and PTTAs.

The Capability Maturity Model Project maintains a model describing how organizations can improve their software process maturity. This model will be continuously updated with the state of the art as it evolves in software engineering, total quality management, and other relevant areas of improvement. It will elaborate on software development practices that provide clear strategies for capability maturity growth and improvement.

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Capability Maturity Model

Version 1.1 of the CMM was completed this quarter. CMM v1.1 is now available by FTP over the Internet; paper copies have been mailed to the members of the CMM Correspondence Group and submitted to the normal distribution channels (Research Access, Inc.; National Technical Information Service; and the Defense Technical Information Center).

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Empirical Methods

The Empirical Methods Project develops, evaluates, and validates products (e.g., questionnaires and tests, methods, and models) for use in baselining and measuring software process improvement.

Prototype process maturity questionnaires based on the CMM were developed in conjunction with the release of the CMM v1.1. Usability testing of these maturity questionnaires (MQ) began in March and will be completed in the third quarter. The MQs will incorporate the usability data collected from 268 people in 8 organizations during 1992. The SEI is testing the v1.1 MQ prototypes in several industry and government organizations to improve MQ clarity and usability. Project members are working with the Software Process Assessment (SPA) Project and SPA Associates in pilot and field testing of questionnaires in the updated SPA method.

This quarter, Empirical Methods staff members developed alpha versions of questionnaires. These questionnaires will capture consistent information to:

- Determine the scope of SPAs and Software Capability Evaluations (SCEs).

- Help with selecting projects to include in a SPA or SCE.

- Collect information about the people completing the maturity questionnaires for use in efficient planning of the on-site period for SPAs and SCEs.

The questionnaires are also being field tested with the SPA method update.

Empirical Methods staff members are collaborating with a resident affiliate from Pacific Bell to prototype an *instant profile* product, which is a supplemental appraisal method to check software process improvement between SPAs. This joint product development effort began in early 1992 and resulted in pilot and division-wide implementation of the instant profile within Pacific Bell during 1992.

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Software Process Assessment

The Software Process Assessment (SPA) Project helps organizations improve their software development process by providing a structured method for assessing their current practice, as well as continuously improving the assessment method and ensuring its focus on organizational process improvement. The objectives of the assessment method are to understand an organization's current practices; identify key areas for improvement, utilizing the SEI process maturity model as a framework; and help the organization initiate those improvements.

This quarter, SPA project members provided authorized assessment coaching services to an existing TO&P client, AMC at Fort Leavenworth, Kansas. In addition, project staff prepared materials for and sponsored the delivery of assessment training to 24 additional personnel from the existing licensed organizations.

SPA project members completed the first draft of the updated SPA method to include the use of the CMM v1.1 in its process. The updated method was exercised extensively in an SEI internal simulation. It was then updated based on lessons learned from the simulation exercise, then successfully used in a full external assessment.

During this quarter, SPA staff continued to consult with various industry and government software organizations that are involved in process improvement activities and assessments.

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Software Capability Evaluation

The Software Capability Evaluation (SCE) Project defines, develops, and evolves a method which helps government acquisition organizations evaluate the capability of contractors to develop and maintain software. SCE is a method for evaluating the software process of an organization to gain insight into its software development capability. Project members document the method, train the software community in its use, develop guidance materials to support the use of the method, and pilot the method with users. Significant effort is also expended communicating with the software community about the SCE method.

This quarter, SCE and SPA project leaders jointly developed a document entitled "Requirements for a Common Rating Framework for CMM Based Appraisal Methods." The requirements outlined in this document apply to CMM-based appraisal methods such as SCE and SPA. Comments on the requirements document have been received from the SCE Advisory Board and are being incorporated into the Version 1.0 document. An SEI development team is using this as a working document in creating a new rating method for use in these methods.

A working draft of the revised "SCE Method Description" document (MDD) was completed and reviewed by the SCE Advisory Board for review. Comments indicate that a significant improvement has been made in the product since the last draft was reviewed. This will be the first public documentation of SCE available to the entire software community. The next draft will go to the SCE Review Group for further review by the community.

A needs document and specification development plan have been created for an Electronic Tool Assistant. Both documents are part of an effort to create automated support tools for CMM-based appraisal methods.

The project configuration management system was updated in accordance with the comments and suggestions that the SCE Advisory Board provided. A framework for the evolution of the method (the Structured Transition Approach) was provided to the SCE Advisory Board and accepted as a sound framework for systematically evolving the method. The board requested more details about implementing the framework. These details will be presented at the next meeting.

Development of the "Guide for Implementing SCE on Software Intensive Acquisitions" continued. The customer is referring to this tailored product as the "Implementation Procedures Document." Comments have been received from the Air Force customer for this product and they were incorporated into the guide. The guide is in final review and edit with the customer.

A meeting was held with Defense Systems Management College (DSMC) concerning the SCE Train the Trainers Course. DSMC cannot proceed in developing the course with the SEI until a DoD agency provides direction and funding to them to help make this happen.

The SCE team training course, scheduled for February, was canceled because of shifting schedules. Teams planned for February will attend the April team training. Team training was conducted in March at Electronic Systems Center (ESC) Hanscom AFB. More than 20 individuals were trained on four teams. One team was from a non-DoD agency.

Project members conducted a one-day SCE overview seminar at the SEI in February. Approximately 25 participants attended.

Project members supported DSMC instructors in delivering a module on SCE during the Program Managers Course (PMC) at DSMC. DSMC instructors now teach this overview material independently. This module will become a standard part of the PMC. Also, a project member presented modules on SCE at the DSMC Management of Software Acquisition Course. This is a standard offering.

The two-hour SCE Overview was presented to the Defense Logistics Agency Software In-Plant Quality Evaluation Conference in February.

A series of meetings was held to review the status and plans for the remainder of the current Computer Resource Technology Transition Program (CRTTP) TO&P. Several deliverables were provided to the CRTTP under a TO&P:

- One project member observed the Joint Software Technology for Adaptable, Reliable Systems (JSTARS) program SCE conducted March 22-26. A lessons learned report was delivered to the JSTARS office in March. Also, recommended changes to the Award Fee Plan were delivered to the customer in February.

- A project member continued direct support of the SCE National Oceanographic and Atmospheric Sciences Agency pilot partner. He forwarded example Request for Proposal language to the program office focal point for executing a contract modification to allow the conduct of an SCE.

During this quarter, several SCE site visits were observed by project members. Two project members advised and observed a company-internal SCE by one of the SEI's affiliate organizations. This was the beginning of moving the SCE method towards supporting industry applications of the method.

The SCE Advisory Board met in February. The SCE Review Group was formed in February. The review group consists of 32 individuals, including the 8 Advisory Board members, who represent their organizations in reviewing SCE method products.

The SCE Navy resident affiliate presented an SEI Overview to his home organization, Naval Surface Warfare Center. The presentation was given to the Center Board of Directors and to the Department Board of Directors.

Work continued on generating potential TO&P or client relationships with several non-DOD agencies, including the Defense Logistics Agency, the Coast Guard, the FBI, the General Services Administration, the Internal Revenue Service, and the SDIO.

SCE project members continued to support efforts to develop DoD policies on the use of SCE. Project members have also been supporting efforts for the United States Air Force (USAF), and with AMC and ESC policy planning groups. A "Best Practices" letter signed by the ESC commander in March strongly encouraged ESC program managers to use the SCE method on their programs. The ESC Systems and Software Design Center is the designated focal point for SCE implementation at ESC.

The SCE project continued to support an AFMC working group that is chartered to investigate how current evaluation methods used by the USAF (including SCE) might be merged into one technique. Various product materials have been sent to the group and hands-on work developing the Software Development Capability Evaluation work products has been provided.

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**Process Program
Reports**

January — March 1993

Capability Maturity Model for Software, Version 1.1
(CMU/SEI-93-TR-24)

Key Practices of the Capability Maturity Model, Version 1.1
(CMU/SEI-93-TR-25)

For information about obtaining copies of SEI reports, see page 34.

Real-Time Distributed Systems

The goal of the Real-Time Systems Program is to improve the development of real-time distributed systems by integrating software engineering with systems engineering and reducing the risk associated with new technology.

The Rate Monotonic Analysis for Real-Time Systems (RMARTS) Project aims to ensure that rate monotonic analysis (RMA) and scheduling algorithms become part of the standard practice for designing, building, troubleshooting, and maintaining real-time systems. RMA helps engineers understand and predict the timing behavior of hard real-time systems to a degree not previously possible.

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Rate Monotonic Analysis for Real-Time Systems

This quarter, the first edition of a handbook on RMA was delivered to the publisher. The handbook, entitled *A Practitioner's Handbook for Real-Time Analysis: Guide to Rate Monotonic Analysis for Real-Time Systems*, will be published by Kluwer Academic Publishers in the summer of 1993. The handbook codifies the principles of RMA in a manner that is easily accessible to real-time systems practitioners.

The handbook is organized into four parts:

1. **Introduction**. This part provides an introduction to the organization of the handbook and a tutorial that acquaints the reader with the fundamentals of RMA.

2. **Foundations**. This part contains foundation material for applying RMA, a framework for standardizing the description of real-time situations, and the analytical techniques for computing schedulability results.

3. **Real-Time Situations**. This part is the core of the handbook. It contains a collection of small, self-contained modules, each of which describes a situation that a practitioner might encounter as part of a larger system.

4. **Case Studies**. This section contains two case studies that illustrate how to apply RMA knowledge contained in the rest of the handbook to realistically complex systems.

Delivery of the handbook concludes the work of the RMARTS Project.

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Ada 9X — Review

The SEI is supporting the revision of the Ada programming language in a variety of ways. One member of the technical staff is a participant in the Ada 9X Distinguished Reviewers Group, which is responsible for reviewing the ongoing revision work. This group meets periodically to review the progress of the revision. Another staff member chairs the Ada Compiler Validation Capability Review Team, which is responsible for reviewing the direction and content of the test suite that will be used to validate Ada 9X compilers. The SEI also supports outside experts who participate in the Ada 9X effort as distinguished reviewers and as Ada Compiler Validation Capability Review Team members. Finally, the SEI provides electronic mailing facilities to the Ada 9X project and to the Ada Joint Program Office, facilitating communication among the various groups interested in the Ada standard and its revision.

This quarter, meetings of both review groups were held, and documents pertaining to the efforts were reviewed.

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Real-Time Simulators

Real-time simulators, especially flight simulators, have traditionally used a software architecture that is optimized for efficiency. The focus on efficiency has complicated the achievement of certain types of functionality and has caused severe problems in maintaining and modifying software. Understanding the design tradeoffs involved in emphasizing certain non-functional qualities like the ability to maintain and modify will enable designers to develop model software architectures that satisfy these qualities, thereby improving the process of developing real-time simulators.

The goals of the Real-Time Simulators Project are to:

* Extend, validate, and document flight simulator and other real-time simulator architectures in a form that is accessible to practitioners and acquisition personnel.

* Understand and codify the relationship between non-functional quality goals and simulator software architectures.

This quarter, project members delivered a draft of the first two parts of a guidebook on the air vehicle portion of flight simulators to the Air Force Aeronautical Systems Center (ASC) Program Office for Simulators and Training. The guidebook will contain 20 chapters and several appendices, which will provide examples produced from the development of the T39A trainer. The remainder of the guidebook will be completed in 1993.

Project members conducted a focus group with personnel from the National Security Industrial Association (NSIA). The group reviewed the draft and suggested improvements.

Project members produced a report for the Defense Modeling and Simulation Office. The report describes the essential characteristics of three solutions to problems within the DoD simulation domain: structural models, aggregate level simulation protocol, and distributed interactive simulation.

The Dependable Real-Time Software Project addresses the need for predictability and dependability in embedded computing applications. Examples of embedded computing applications are distributed process control for advanced manufacturing, multimedia high-performance networks, medical equipment, and defense systems.

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Dependable Real-Time Software Systems

The three major tasks of this combined project are to:

1. Investigate the use of analytical redundancy for application-level fault tolerance. Currently, defects in complex software account for most system failures. This software architecture uses simple and well-understood software to guarantee a baseline solution and an envelope within which solutions from complex software must lie. The architecture enables complex software with residual defects to improve baseline performance without crashing systems.

2. Combine system-level fault tolerance with RMA. The development and transition of generalized RMA theory has been cited as a success in the DoD 1991 Software Strategy Plan and in the 1992 National Research Council report entitled *A Broader Agenda for Computer Science and Engineering*. However, current technology for system fault tolerance still assumes the use of the old cyclic executive approach as the basis of timing control.

3. Develop a framework for structuring, classifying, and disseminating fault tolerance technology in cooperation with government agencies, universities, and industry.

This quarter, project members demonstrated software fault tolerance experimentally, using a refined version of the simplex software architecture and RMA to control multiple unstable devices. Project members demonstrated that under the control of simple and reliable software, an unstable device can improve its control performance if new and improved software is added to the system. This demonstration illustrated that the new technology can be used to upgrade mission-critical systems online. Furthermore, the demonstration showed that the simple software will take over the control if the new software malfunctions, further illustrating the promise of this technology.

This quarter, Dr. Gary Koob and Mr. James Smith of the Office of Naval Research visited the SEI for a demonstration of the initial experiments. Both were pleased with the results and indicated that they wanted the project to continue the work as planned. Representatives of Texas Instruments were also present for the demonstration and expressed interest in the possibility of cooperative efforts.

Project Members prepared for the Dependable Software Technology Exchange, funded by the Air Force Space and Missile Systems Center and the Office of Naval Research. The purpose of the technology exchange was to bring together researchers, contractors, and government personnel to discuss dependable software needs.

For the first exchange, four topics were covered: formal methods and verification, requirements, operating system support, and object-oriented programming and design. Each session included a technology lecture, an application lecture, and a panel discussion.

Work continued on a fault tolerance handbook. This handbook will be a followup to the *Conceptual Framework for System Fault Tolerance*, which was published in late 1992. The handbook will present the state of the art in terms of the state of the practice by discussing techniques used to achieve fault tolerance and showing where they have been used successfully (or unsuccessfully) in practice.

The project was represented at a workshop on fault and error models and at the winter meeting of the International Federation of Information Processing (IFIP) Working Group 10.4 on Dependable Systems. A project member participated as an invited panelist at the 1993 Reliability and Maintainability Symposium in Atlanta.

The Transition Models Project is developing a set of methods and supporting materials such as guidelines and checklists for planning and implementing software technology transition. These materials will be used by software technology producers and consumers both inside and outside the SEI.

Transition Models staff members provide other SEI staff—including management—with education and training on technology transition concepts and approaches. Additionally, project members provide limited consulting on software technology transition to members of SEI constituencies, and maintain contact with researchers and others interested in technology transition from business, government, and academic domains.

This quarter, project members participated in several meetings of the Council of Consortia Technology Transfer Models and Best Practices Working Groups. These groups are developing a concept for a product that would provide online resources and interactive guidance for technology transfer managers. Discussions have been held with senior management from the National Technology Transfer Center,, who have expressed interest in collaborating in this effort.

Project members are serving as program chair and organizing chair for the forthcoming Working Conference on Diffusion, Transfer and Implementation of Information Technology. This conference is sponsored by Technical Committee 8 (Information Systems) of the IFIP, and will be held at the SEI on 11-13 October. The conference is targeted at researchers and practitioners, and will consider the viability of forming an IFIP working group in the Pittsburgh area. During this quarter, the program committee was selected and the Call for Participation and Papers was mailed and distributed over the Internet.

Project members held a three-day working meeting with Professor Natalia Juristo of the Faculdad Informatica, Universidad Politecnica de Madrid (UPM). The SEI and the UPM have signed a Memorandum of Understanding to collaborate on a prototype system to support change agents who must introduce software technologies into organizations. Project members also participated in technical interchange with two members of the ESPRIT Bootstrap Project.

The project leader participated in a two-day technical interchange and workshop on technology transfer at Siemens Corporate Research Center in Princeton, New Jersey. While there, she met with members of five projects and discussed their approaches to technology transfer. During this visit, she also presented a briefing on SEI technology transfer work.

Durra: A Task Description Language User's Manual, Version 2
(CMU/SEI-92-TR-36)

For information about obtaining copies of SEI reports, see page 34.

Software Engineering Techniques

The goal of the Software Engineering Techniques Program is to increase the use of engineering knowledge for effective and efficient production of large software-intensive systems through a model-based software engineering approach and engineered project support environments.

The program consists of three projects. The Computer-Aided Software Engineering (CASE) Environments Project addresses issues of engineering of environments. The Application of Software Models Project addresses the systematic creation and use of models in application engineering. The Software Engineering Information Modeling Project addresses issues of capturing, representing, and making accessible increasing amounts of engineering information ranging from requirements to engineering knowledge typically found in handbooks.

The goal of the Application of Software Models Project is to address the systematic creation and application of models in application engineering. These models form a codified technology base of engineering knowledge. Software engineers use this technology base to support:

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Application of Software Models

- Analysis of customers' needs.

- Synthesis of solutions based on recognized commonalities or on variations from previous solutions.

- Reuse and re-engineering of legacy software.

The approach to developing software applications is a component of the model-based software engineering approach being promoted by the Engineering Techniques program.

This quarter, project members completed an Ada demo system of Army movement control and are working with staff at the Army Communications and Electronics Command to port the application to the Army Common Hardware/Software Platform. Project members have provided Army contractors with the software to complete the port.

Project members delivered a set of slides to the Army Director of Information Systems for Command Control Communications and Computers. The presentation covers their use of object-oriented technologies and discusses how these technologies can be used within model-based software engineering.

The project is continuing to support the Joint Modeling and Simulation System (J-MASS) by reviewing their executive design, simulator design criteria, and consistent use of the structural model. A project member reviewed and provided comments on the latest version of the J-MASS version of the object-connection update, the architectural design team report, and the competitive risk-reduction effort.

Another project member presented project plans for the Strategic Defense Initiative Office (SDIO) tasks to Col. Phelps, who supports the plan. Project members have prepared a draft statement of work, which is currently in internal review. These areas of work address improvements in the development of software for battle management command, control, and communications systems (BMC3). The project will support SDIO in developing:

- Models to understand and represent user needs and variations.

- Models to support flexible architectures and designs.

- Processes to turn the models into BMC3 applications.

Project members have discussed with HP the possibility of supporting the restructuring of their Open Systems Software Division (OSSD). The SEI will work with several members of the HP reuse department. This joint effort will help OSSD define and produce a technology base (domain kit) and establish a process (flexible software factory) for using the models in the technology base for software engineering.

During this quarter, project members met with the Central Archive for Reusable Defense Software staff in West Virginia to explore possible interactions. The following possible uses of this technology were discussed:

- Movement control models repository.
- Application development support tool.
- Joint domain analysis efforts.

The Software Engineering Information Modeling Project is investigating the creation, maintenance, and use of models critical to software engineering. The project is conducting research into the techniques and tools that will improve a software engineer's ability to capture, represent, and access reusable software engineering information, knowledge, and models. Work has begun to develop pilot technology that facilitates access to software engineering information, initially focusing on the improvement of requirements capture and analysis.

This quarter, the project began a joint effort with Texas Instruments to develop multimedia engineering experience modules. The creation of these modules will be based on ongoing project work to develop multimedia knowledge representation techniques.

Project members continue to work with the Naval Supply Systems Command on a TO&P entitled "Research and Development of Advanced Technology in Support of the Naval Supply Systems Command." In this effort, project members are providing technical support for system requirement determination and evaluation of process, knowledge, and data requirements to automatically convert hardcopy engineering drawings into computer models.

As vice-chair of the Institute of Electrical and Electronic Engineers (IEEE) Task Force on Multimedia Computing and chair of the IEEE Tutorial and Workshop on Multimedia Computing, the project leader organized and held a tutorial and workshop in March. One project member presented "Multimedia Applications and Abstractions" at the tutorial. Project members attended the tutorial and workshop and assisted in capturing the outcomes of the workshop. The project leader has been named the program chair for the 1994 IEEE International Conference on Multimedia Computing and Systems.

The project leader wrote "Multimedia Computing: Applications, Designs, and Human Factors." This paper will appear in *User Interface Software*.

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Software Engineering Information Modeling

The CASE Environments Project addresses the problem that, while a large number of software tools and integrating frameworks are currently available, generally there is no clear evidence to determine the precise impact of tools on productivity and quality. In addition, the integration of different tools is problematic, and the organizational issues for adopting technology and the support of tools for an organization's software development process are not well understood or generally agreed upon.

This overall problem is addressed through three general approaches:

1. Developing conceptual frameworks to understand tool integration and tool adoption from the perspectives of technical mechanisms, user services, and organizational processes.

2. Viewing both integration and adoption as design activities that require an analysis of the current state and a coherent process to move to a desired state.

3. Verifying the conceptual frameworks through small-scale experiments.

The CASE Technology Project has three major task areas:

1. Environment support for configuration management

2. Environment support for integration

3. CASE adoption

The project has identified the state of commercial technology regarding software configuration management (SCM) support. This has been captured through a spectrum of concepts and observed paradigms. Configuration management (CM) capabilities can be found in SCM tools, CASE tools, and environment frameworks, each implementing its own variant of some of the concepts. This variety leads to the need to integrate tools with different SCM capabilities into a software development environment, and the desire for a unified SCM model that can be adapted to different processes. The result is project activity in issues of consolidation of SCM concepts, integration of SCM and CASE tools, and SCM support for the CM process and its relationship to the CMM.

The need for integration of SCM and CASE and a number of emerging environment technologies has led to increased project activity on environment architectures in support of integration. Various government and industry efforts are focused on environment reference models and interface standardization. New insights are gained into the problem of environment integration, taking into consideration environment framework mechanisms, engineering service concepts and information models, and engineering processes.

During the first quarter, project members were major contributors to Version 1 of the Navy's Next Generation Computer Resource Project Support Environments Standards Working Group reference model on environment integration. In addition, project members delivered papers on integration at several workshops, including the Aerospace Industries Association of America Environment Integration Workshop in Dallas.

This quarter, project members continued to focus on improving the ability of SEI sponsors and affiliates to make informed decisions about tool adoption and on improving their practice in the use of CASE tools. Project members also provided information to tool vendors on current tool usage and gaps in current technology.

Guide to CASE Adoption
(CMU/SEI-92-TR-15)

Control Integration Through Message Passing in a Software Development Environment
(CMU/SEI-92-TR-35)

An Annotated Bibliography on Integration in Software Engineering Environments
(CMU/SEI-92-SR-08)

For information about obtaining copies of SEI reports, see page 34.

Software Engineering Techniques Reports

January — March 1993

Software Risk Management

The objective of the Software Risk Management Program is to improve the management of risks that arise in the development of software-intensive systems. Project members are assessing the state of the practice of software risk management, developing methods and processes to improve the state of the practice, and transitioning these methods and processes into practice.

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Government Risk Management

The goal of the Government Risk Management Project is to help government program managers become effective risk managers. Our goal is to enhance the capability of government agencies to successfully manage system acquisition by:

1. Improving software engineering methods through the application of a software risk management discipline.

2. Fostering the concept of "team" risk management.

The scope of this project is to develop and transition into practice a comprehensive set of software risk management products that are aimed at serving program managers' needs for effective support in managing the acquisition and development of large, software intensive systems.

The risk management product set will focus on issues of modeling acquisition processes, developing risk management methods to support these processes, and improving communications about risk within government and between government and its industrial contractor base. The primary emphasis is on enhancing the capability of the customer and supplier team to manage risks in software development.

This quarter, project members formulated the concept of "team" risk management that emphasizes closer customer and supplier working relationships to manage program risks. This concept is being actively pursued with strategic collaborative partnerships with the Navy Program Executive Office for Anti-Submarine Warfare, Air Assault and Special Missions Programs, (PEO(A)), and the National Oceanographic and Atmospheric Agency.

The Navy PEO(A) activities included continued detailed planning and evolution of the "team" risk management process and establishing program office commitments with both the Navy and the contractor.

This quarter, project members supported the Navy PEO(A) by conducting an assessment of one of its program contractors. The objectives were to demonstrate the value of risk management and leave the contractor with current risk management methods. The results identified program-specific risks and remained confidential to the contractor.

The project briefed a Navy PEO(A) contractor on the "team" risk management concept and established commitment for collaboration. Training is planned to take place during the second quarter.

Project members conducted a risk assessment with the National Oceanographic and Atmospheric Agency Advanced Weather Interactive Processing System Program Office and presented the "team" risk management concept for potential follow-on collaborative work. The "team" risk management concept was also presented to the National Oceanographic and Atmospheric Agency System Program Office as a way to pilot risk management improvement.

The project investigated risk-driven acquisition strategies and explored the feasibility of using an existing model Software Acquisition Process Model developed by the NAVAIR as the project starting point.

The project supported preparation for the Software Risk Management Conference that took place in March and presented its concept of customer/supplier "team" risk management at the conference.

A project member served as an invited panel co-chair at the NSIA Workshop on Re-Engineering. The panel addressed the risk issues in re-engineering.

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Industry Risk Management

The goal of the risk taxonomy portion of this project is to develop the taxonomy-based questionnaire and supporting methods so that both industry and government can easily integrate the methods into their daily risk management process.

This project is working with the Government Risk Management Project and has been merged with the Industry Risk Management Project to ensure their requirements of the taxonomy-based questionnaire are met and that the questionnaire and supporting methods are integrated smoothly into their planned products.

The project is developing phase-sensitive and domain-sensitive taxonomy-based questionnaires. Although the questionnaire variance from phase to phase and from domain to domain is small, it is significant in identifying software technical risk. The structure of the taxonomy-based questionnaire will remain unchanged over the variation of the questionnaire.

The taxonomy method of risk identification has evolved from a program of research, analysis, and field testing. The field testing validated the ability of the method to identify known risks and also served as a data-gathering activity for improving the taxonomy method including both the questionnaire itself and the process of applying the taxonomy. The field tests also exposed the taxonomy method to a broad spectrum of companies covering several application domains, development methods, and risk management techniques.

The current version of the taxonomy-based questionnaire and the risk identification process are based on 11 field tests in 9 corporations. Of these, 2 programs were in the maintenance phase, 1 was a precontract award, 1 was at alpha testing, 1 was in requirements analysis, and the remainder were somewhere between preliminary design review and critical design review. Domain coverage of the programs includes command, control, communications, and intelligence; embedded satellite system; civilian command and control; and information systems.

SEI Services

SEI Services works with other groups in the SEI to develop, deliver, and transition services that support the efforts of SEI clients to improve their ability to define, develop, maintain, and operate software-intensive systems. To accelerate the widespread adoption of effective software practices, SEI Services works with client organizations that are influential leaders in the software community, promotes the development of infrastructures that support the adoption of improved practices, and transitions capabilities to government and commercial associates for use with their client organizations.

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Computer Emergency Response Team

The Computer Emergency Response Team (CERT) was formed by DARPA in November 1988 in response to the needs exhibited during an Internet security incident. The CERT charter is to work with the Internet community to facilitate its response to computer security events involving Internet hosts, to take practice steps to raise the community's awareness of computer security issues, and to conduct research targeted at improving the security of existing systems.

This quarter, a CERT staff member received an Electronic Freedom Foundation Pioneer award at the 3rd Annual Conference on Computers, Freedom and Privacy. He is one of the two initial developers of the software that led to today's USENET.

Several members of the CERT Coordination Center attended the USENIX Technical Conference, which was held in California in January. Conference attendance exceeded 1000. CERT presented a birds-of-a-feather session that was attended by 60-70 people. One of the main items of discussion at the session was the CERT advisory concerning the keystroke logging banner.

One staff member was invited to chair a session at the next USENIX; this session will be a review of the Security Symposium held last year.

Also in January, a CERT staff member attended the Workshop on Network and Distributed System Security, sponsored by the Privacy and Security Research Group of the Internet Engineering Task Force. The focus of the meeting was on implementation and design of security technology for the Internet.

In addition, the CERT participated in the Security Alliance For Enterprise Computing (SAFE) meeting in New York. SAFE consists of Information Technology Consumers and Vendors with a commercial focus who are working towards increasing the awareness of:

- the need for secure computing in the commercial sector
- UNIX security related resources
- how UNIX system technology can support the security needs of the commercial enterprise computing environment.

This group is working on System Administrator policy guidelines for corporate users and UNIX vendors.

At the American Bankers Association National Security and Risk Management Conference in Orlando, the Coordination Center manager gave a presentation on how to implement the CERT philosophy.

Staff members attended the Federal Information Systems Security Educators Association meeting in Gaithersburg, Maryland, in February, where they presented an overview of CERT training course offerings.

Also in February, a CERT staff member gave the keynote luncheon talk at a symposium on Network Management, Interconnectivity, and Security, sponsored by the Association for Information Technologies. The symposium was held in Madison Square Garden in New York City, and attendees were predominately from Fortune 500 companies. A CERT staff member also spoke on network security at the March Interop Conference in Washington D.C.

This quarter, several CERT members were interviewed by the media, including Byte Magazine and UNIX Review.

A paper by a CERT staff member was published in the February issue of *Computers and Security*: "Beyond Preliminary Analysis of the WANK and OILZ Worms: A Case Study of Malicious Code."

The Organization Capability Development (OCD) function supports SEI clients' software process improvement efforts by helping them develop the capability to manage the organizational aspects of improvement at their sites. Services include organizational assessment, vision setting and dissemination, strategic planning, transition infrastructure development, executive consulting, cross-functional team development, managing technological change, and consulting skills for SEPGs. The goal of the function is to provide to clients the self-sustaining capability of managing their own long-term improvement.

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Organization Capability Development

This quarter, OCD staff conducted the *Managing Technological Change* course for executives at AMC (Fort Monmouth) and twice for the AFMC. In addition, the *Managing Technological Change* course was presented to National Aeronautics and Space Administration (ESIP), Embedded Computer Resources Support Improvement Program, and for the public at the SEI.

This quarter, the "Consulting Skills Workshop" was held for ESIP and at the SEI for the public. Also, a workshop for senior management on how to work effectively with the SEPG was prototyped and conducted for AFMC. Further software process improvement support was provided for the AFMC, San Antonio Air Logistics Center (ALC), Oklahoma City ALC, Aerospace Guidance and Metrology Center, Warner Robins ALC, Ogden ALC, AMC, HP, and Xerox.

OCD participated in the alpha test of the updated SPA method conducted at an AFMC client site.

SEI Products

With the goal of helping end-users help themselves, SEI Products works with other groups in the SEI to develop an integrated set of products and services for managers, practitioners, and educators. SEI Products ensures that the results of SEI work are in a form that the software community can easily and effectively use to improve software practice and that educators can use to improve software engineering.

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Academic Education

The Academic Education Project focuses on the long-term development of a highly qualified work force. The project promotes and accelerates the development of software engineering as an academic discipline. The project is developing model curricula and promoting the establishment and growth of software engineering programs, as well as working to increase the amount of software engineering content in computer science programs. The project produces educational materials that support the teaching of software engineering in universities.

This quarter, project members conducted faculty development workshops in conjunction with the 24th Association for Computing Machinery (ACM) Special Interest Group on Computer Science Education Technical Symposium on Computer Science Education. Approximately 30 college and university professors attended the workshops, the topics for which included:

- Experimental methods
- Engineering measurement
- Software process improvement
- Software quality

The Continuing Education Project interacts with industry and government to increase the availability of high-quality educational opportunities for software practitioners and executives. The project produces the Continuing Education Series and the Technology Series. The Continuing Education Series provides video-based courses designed for clients' in-house education, and executive offerings designed for decision makers involved in improvement efforts. The Technology Series provides stand-alone presentations that promote awareness of emerging issues and leading-edge technologies.

The three currently offered executive courses (*Software: Profit through Process Improvement, Software Quality Improvement,* and *Software Productivity Improvement*) were updated to match Version 1.1 of the CMM.

The 7th public offering of a course entitled *Software: Profit through Process Improvement* was held at the SEI early this quarter.

The course entitled *Software: Profit through Process Improvement* was also offered on-site to 30 students at Redstone Arsenal in Huntsville, Alabama, in March.

The 6th public offering of the *Software Quality Improvement* course was held at the SEI in February. Among two SEI affiliates, participants from AT&T, US Treasury Department, Computer Sciences Corp., SWIFT, and National Systems & Research Co attended this course.

The course *Software Productivity Improvement* was taught in March to students from AT&T, E-Systems, and SWIFT.

The first offering of a new executive course, *Software Risk Management,* has been scheduled to take place in June 29. Promotional materials were distributed to more than 200 people at the SEI Software Risk Conference, which was held in March.

An instructor training session for the Continuing Education Series practitioner course *Software Requirements Engineering* was held in March. Three organizations received the training and course materials: ITT, National Defense University, and the Online Computer Library Center.

Twenty videotapes and other materials from *Software Project Management,* a Continuing Education practitioner course, were purchased by Sterling Software, ITT Research, and PARAMAX.

This quarter, nine academic Series courses were sold during the quarter.

Also during this quarter, 41 Technology Series videotapes were sold. The currently available tapes are: *Applying Software Engineering Skills to Writing*, by Linda Pesante; *Executive Leadership for Software*, by Watts Humphrey; and *Software and Some Lessons from Engineering*, by Mary Shaw.

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Master of Software Engineering

In response to industry's growing demand for skilled software developers, Carnegie Mellon University (CMU) offers a 16-month master's degree program in software engineering. The program is a cooperative effort of the CMU School of Computer Science and the SEI. The core of the program is based on the SEI curriculum recommendations for Master of Software Engineering (MSE) programs. The MSE Project also produces the Academic Series, a set of video-based, graduate-level courses on software engineering.

This quarter, a new Academic Series course was released: *Software Construction with Ada*. An elective in the Carnegie Mellon MSE program, the course was videotaped in 14 class meetings of 60 minutes each. It focuses on component-level programming to achieve higher degrees of reusability and reliability, and thus increased productivity. The Ada language is used because is possesses features that are useful for reusing software and for building component libraries and for its importance in the area of real-time embedded systems. The Academic Series course includes a set of videotaped lectures by Jorge Diaz-Herrera and an instructor's book.

Also released this quarter was a curriculum module, *Specification and Verification of Concurrent Software*, which includes an extensively annotated outline of the subject area, advice for teaching the subject, and an annotated bibliography.

Academic Legitimacy of the Software Engineering Discipline, was published as an SEI technical report. This report addresses the issues faced by software engineering faculty.

Among the core courses offered to MSE students this semester are *Software Design*, *Software Analysis*, and *Software Creation & Maintenance*. In addition, the Software Development Studio continues from the fall semester.

SEI Academic Series courses are also being distributed through the National Technological University (NTU), which delivers courses by satellite to corporate and government sites. For the spring semester, NTU is presenting *Software Creation & Maintenance* and *Software Verification & Validation*.

Academic Legitimacy of the Software Engineering Discipline
(CMU/SEI-92-TR-34)

Materials for Teaching Software Inspections
(CMU/SEI-93-EM-7)

Lecture Notes on Software Process Improvement
(CMU/SEI-93-EM-08)

Formal Specification and Verification of Concurrent Programs
(SEI-CM-27-1.0)

Technology Transition Initiatives

The Process Research Project investigates the factors that limit software development performance by conducting research on the use of software process principles by individuals and small teams. This research is seeking insight into the processes, tools, and methods that will be most helpful in improving the performance of software engineering professionals.

The Process Research Project continues to explore the use of statistical process management methods by individual software practitioners. Early work has demonstrated the potential value of such methods in improving the quality, productivity, and predictability of the work. With the completion of Milestone 1 this quarter, the project has moved from the early exploratory phase to addressing the feasibility of more general application of the personal software process (PSP) method. Principal emphasis has thus moved to working with academic and industrial groups. Because of the substantial changes required in individual and management attitudes and practices, it is expected that both academic and industrial adoption of the method will be slow. Work is thus underway with several groups with the objective of gaining usage experience from some of them during 1993 and 1994.

The principal focus of the industry activities has been with Siemens Research of Princeton, New Jersey, and AIS of Peoria, Illinois. A visit was made to Siemens in January and to AIS in March. As expected, both groups are making progress. Two other industrial groups have also expressed interest in the PSP work. Meetings have been arranged to take place in the second quarter.

A professor at the University of Idaho is currently teaching a course using various components of the PSP method. While some U.S. universities have expressed interest in the PSP method, none are yet actively planning to offer a dedicated courses on the method. A course proposal is being prepared, and an effort will be made to find a university that will offer the course during the 1993-1994 academic year. Should the course materialize, it is expected to require a substantial amount of project support.

This quarter, the project leader visited the Air Mobility Command software group at Scott AFB to meet with senior management and give a presentation on software process improvement concepts and issues.

This quarter, an update of the PSP process was completed. This PSP details the lessons learned over the last several months.

This quarter, the proposed IEEE/SEI Award for Process Achievement was approved by the IEEE Computer Society with the project leader serving as chairman of the review committee. Other review committee members are Dr. Vic Basili, Dr. Barry Boehm, Dr. Manny Lehman, and Dr. Bill Riddle. The award will be jointly announced by the SEI and the IEEE and it is expected to motivate people to publicize their process improvement results. This, in turn, should provide increasing evidence of the benefits of software process improvement.

The project leader attended the 2nd International Software Process Conference in Berlin, Germany, to present a technical paper. The project leader also attended the Eighth International Software Pro   Workshop in Germany.

Program Development

The vision of the Program Development Division (PDD) is to serve customer needs by being the voice of the customer to the SEI and the voice of the SEI to the customer. The PDD mission is to understand the key requirements of SEI customers, translate these into responsive SEI program specifications consistent with the SEI mission, and facilitate the effective transition of best software engineering practice into use.

PDD accelerates the transition of new SEI software technologies and methods by disseminating information, providing mechanisms for collaboration and technology exchange, and offering customers the opportunity to participate in technical interchange meetings, workshops, and educational offerings. Efforts used to facilitate this transition include the Customer Relations information line, the subscriber program, the resident affiliate program, events such as the annual SEI Software Engineering Symposium and Visitor's Days, and distribution partners.

●●●●●●●●●●●● The subscriber program, in effect since January 1992, is open to any individual with a U.S. mailing address. Subscribers receive regular publications such as *Bridge* and the *Annual Technical Review*, a discount at the annual SEI Software Engineering Symposium, a 10% discount on all SEI technical reports ordered through Research Access, Inc., invitations to selected SEI events (e.g., the annual SEI Symposium), and first notification of SEI course offerings. The 1993 fee for subscribers is $100 per individual per year. The fee is subject to change in 1994, as the benefits are reviewed and amended.

Visitor's Day is hosted by the SEI three times a year to familiarize software practitioners, managers, and educators with the SEI. The next two Visitor's Days are scheduled for 27 May and 18 November 1993. Visitors must pre-register; walk-ins will not be accommodated. Registration forms are available from Customer Relations. (See page 34 for more information.)

The SEI will host the annual Software Engineering Symposium on 23-28 August 1993. This symposium will take place at the David Lawrence Convention Center in Pittsburgh and the theme is "The Business of Software Engineering: The Competitive Edge." This year, the symposium will have a broader focus than it

has had in past years. The symposium will showcase a variety of topics that are important to corporate and government organizations dependent on software engineering. The topics selected will help software managers and practitioners respond better to competition and the changing environment.

For registration information, contact:

> Events
> Software Engineering Institute
> Carnegie Mellon University
> Pittsburgh, PA 15213-3890
>
> Phone: (412) 268-6531
> FAX: (412) 268-5758

For general symposium information, contact Customer Relations. (See page page 34 for details.)

The following organizations sponsored resident affiliates in the first quarter of 1993:

Industry
Computer Sciences Corporation
GTE Government Systems
Hughes Aircraft Company
IBM
Lockheed Missiles and Space Company, Inc.
Pacific Bell
Siemens
Texas Instruments

Government	Air Force	Electronic Systems Division
	Navy	Naval Air Warfare Center
		Naval Surface Warfare Center
	Army	Communications-Electronics Command
	Other DoD	Defense Logistics Agency
		National Security Agency

How to Get Additional Information

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**How to Order SEI
Publicati⌄ns**

For information about purchasing SEI publications, contact one of the
following organizations:

RAI   Research Access Inc.
3400 Forbes Avenue, Suite 302
Pittsburgh, PA 15213
Telephone: 1-800-685-6510
FAX: (412) 682-6530

NTIS   National Technical Information Service
U.S. Department of Commerce
Springfield, VA 22161-2103
Telephone: (703) 487-4600

DTIC   Defense Technical Information Center
ATTN: FDRA Cameron Station
Alexandria, VA 22304-6145
Telephone: (703) 274-7633

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**How to Obtain
Documents with
Anonymous FTP**

Some—not all—SEI documents are available electronically. Send electronic mail to
`info-manage@sei.cmu.edu` for information about obtaining documents via
anonymous FTP on the Internet. Be certain to include your telephone number
in the event that we have difficulty contacting you by electronic mail.

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**How to Get Additional
Information**

For information on the subscriber program and other SEI offerings, contact:

SEI   Software Engineering Institute
ATTN: Customer Relations
Carnegie Mellon University
Pittsburgh, PA 15213-3890
(412) 268-5800
Internet: customer-relations@sei.cmu.edu

List of Acronyms

ACM	Association for Computing Machinery
AFB	Air Force Base
AFMC	Air Force Materiel Command
ALC	Air Logistics Center
AMC	Army Materiel Command
ARPA	Advanced Research Projects Agency
ASC	Aeronautical Systems Center
BMC3	battle management command, control, and communications
CM	configuration management
CMM	capability maturity model
CMU	Carnegie Mellon University
CRTTP	Computer Resource Technology Transition Program
DoD	Department of Defense
DSMC	Defense Systems Management College
ESC	Electronic Systems Center
ESIP	Embedded Computer Resources Support Improvement Program
HP	Hewlett Packard
IEEE	Institute of Electrical and Electronic Engineers
IFIP	International Federation of Information Processing
J-MASS	Joint Modeling and Simulation System
JSTARS	Joint Software Technology for Adaptable, Reliable Systems
MDD	method description document
MQ	maturity questionnaire
MSE	Master of Software Engineering

NAVAIR	Naval Air Systems Command
NAWC	Naval Air Warfare Center
NSIA	National Security Industrial Association
NSUP	Naval Supply Systems Command
NTU	National Technological University
OCD	Organization Capability Development
OSSD	Open Systems Software Division
PDD	Program Development Division
PEO(A)	Program Executive Officer for Anti-Submarine Warfare, Air Assault, and Special Missions Programs
PMC	Program Managers Course
PSP	personal software process
PTTA	Process Technology Transition Affiliates
RMA	rate monotonic analysis
RMARTS	Rate Monotonic Analysis for Real-Time Systems
SCE	Software Capability Evaluation
SCM	software configuration management
SDIO	Strategic Defense Initiative Office
SEPG	Software Engineering Process Group
SPA	Software Process Assessment
SPD	Software Process Definition
SSC	Standard Systems Center
STARS	Software Technology for Adaptable, Reliable Systems
TO&P	technical objectives and plans
UPM	Universidad Politecnica de Madrid
USAF	United States Air Force